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THE CORTICOSTEROID SECRETION IN RABBITS

By V. M. Rodionov, L. O. Orlova and L. I. Tuul'

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THE EFFECT OF DIFFERENT DOSES OF X-IRRADIATION ON
THE CORTICOSTEROID SECRETION IN RABBITS

[Following is a translation of an article by
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In the study of the function of the cortical layer of the suprarenal
glands in irradiated rabbits (two) and rats (one) it has been shown that the
irradiation substantially changes the nature of secretion of these glands. An
increase in the content of 17-cxycorticosteroids in the peripheral blood of
irradiated dogs and monkeys has also been observed during the few days immediately
after irradiation and in the terminal period of radiation sickness (4, 6).

In elucidating the matter of the relationship of the changes in the
nature of secretion of corticosteroids observed after irradiation to the degree of
radiation injury we made an investigation of the function of the cortical layer
of the suprarenal glands in rabbits irradiated with different doses of X-rays.

The irradiation was carried out at 185 kv and 15 ma; filters of one mm Al
and 0.5 mm Cu; a skin-to-tube distance of 60 centimeters. The dose rate was
11 r per minute. Fifty-eight rabbits were used in the experiment. The control
animals were not irradiated. The other four groups were irradiated with doses of

400-600 r, 800-1100 r, 1300-1500 r and 1700-2000 r. On the second day after the irradiation, just as in the preceding work (2) 25-40 cubic centimeters of blood from the suprarenal glands were taken from the animals, and this blood was then treated by the method of N.A. Yudayev, Yu.A. Pankov and K.V. Druzhinina (3). Separation of the steroids was accomplished by the method of paper chromatography using a Bush B₅ (5) unit. The content of corticosterone, hydrocortisone and an unidentified compound "X" were determined in the blood. The volume of blood collected, the time of the collection as well as the weight of the animal and the weight of the suprarenal glands were recorded.

In all the rabbits irradiated, as has been repeatedly noted in the literature, the weight and size of the suprarenal glands were increased. In comparing the data characterizing the ratio of the weight of the suprarenal glands to the body weight of the animals which had been irradiated with various doses of γ -rays a tendency could be noted toward an increase in the weight of the glands with the increase in the dose of irradiation (Fig.1).

Despite the increase in weight and size of the suprarenal glands, the rate of secretion of the total quantity of steroids in the irradiated rabbits hardly increased and was unchanged with the increase in the dose of irradiation (Fig.2). However, in studying the relationship of the rate of secretion of the various cortical hormones to the magnitude of the dose received by the rabbits characteristic features could be observed.

The quantity of corticosterone secreted by the suprarenal gland of the rabbits did not change notably with the increase in the dose of irradiation (Fig.3). However, not only the total quantity of hormones secreted is important in characterizing the functional state of the gland but also the ratio of this quantity to the weight of the gland. In investigating the rate of secretion of the corticosterone in γ per hour for every 100 milligrams of suprarenal gland tissue quite a distinct tendency was observed toward a reduction in the secretion rate of the hormone with increase in the dose of irradiation (Fig.4).

This may apparently be explained by the fact that irradiation of the animals suppresses the corticosterone synthesis or by the fact that the increase in the size and weight of the gland in the irradiated animals occurs because of tissue which does not synthesize corticosterone. The latter seems more probable to us.

A more distinct relationship to the dose of irradiation may be noted in the study of the secretion rate of two other compounds secreted by the rabbit's suprarenal gland.

In the investigation of the secretion rate of hydrocortisone (compound "F") in γ per hour it was shown that this secretion increases distinctly with the increase in the irradiation dose (Fig.5), and thereby it increases much more quickly than the weight of the suprarenal glands. The same rules and regulations were observed also in recalculating the secretion rate per unit of weight of the gland. It may be supposed that in irradiation a stimulation occurs of the synthesis of this corticosteroid. However, this conclusion cannot be considered

final without corresponding morphological data. Hydrocortisone is secreted by the rabbit's suprarenal gland in a small quantity. If the synthesis of it is actually associated with a definite kind of cell in the cortical layer of the suprarenal glands the number of these cells should be insignificant, and increase in their number even by several times could not markedly change the total weight of the suprarenal glands.

The most complex relationship to the dose of irradiation may be observed in the investigation of the rate of secretion of compound "X" (Fig.6) in the rabbits. The production of this substance by the suprarenal glands of rabbits increases markedly after irradiation of the animals with 800-1100 r and decreases with further increase in the dose of X-irradiation. The same rules and regulations are observed also in recalculating the rate of secretion of this compound per unit of weight of the suprarenal gland.

It is interesting that the development of radiation pathology has been associated by some authors with phasic changes in the function of the suprarenal glands: with an increase of it during the first period and a depletion of it at later stages. As is seen from the data presented, the change in the secretion rate of substances synthesized by the suprarenal gland depending on the dose of irradiation received by the rabbit was of a phasic nature only in one case-- with the use of compound "X". To date we do not know the structure of this substance and are not even sure of its biological activity. It would be premature to make any kind of suppositions as to its role in the development of

radiation sickness. However, even the very nature of the relationship of the rate of secretion of this substance to the magnitude of the dose received by the animals is evidence, from our point of view, of the expediency of further study of it.

If the increase in secretion of hydrocortisone and reduction in the activity of the suprarenal gland tissue with respect to the formation of corticosterone can be explained not only by a change in the activity of the enzyme systems participating in the synthesis of these hormones but also by a change in the number of corresponding cellular elements, the latter explanation does not appear very probable with respect to compound "X". The complex relationship between the dose of irradiation and the rate of secretion of this substance as well as the evident lack of a connection between the rate of secretion and the weight of the adrenal glands makes us believe that here we are dealing with the effect of radiation on the very process of synthesis of it rather than on the number of elements synthesizing ~~ix~~ this substance.

In the investigation of the effect of ionizing radiation on the secretory activity of isolated bovine suprarenal glands, Ungar and others (8) found that irradiation of the glands produces a reduction in the total quantity of corticosteroids secreted by them. Rosenfeld and others (9) under the same conditions ~~x~~ as well as Rosenfeld (7) in the study of the function of isolated suprarenal glands of irradiated steers could not detect any kind of characteristic differences in the effect of irradiation on the various enzyme systems participating in the synthesis of corticosteroids. Comparison of these data with those presented

in the present work causes us to believe that the difference which we observed in the effect of increasing doses of irradiation on the rate of secretion of the various corticosteroids cannot be the result of the direct effect of radiation on the suprarenal gland. An indirect effect of radiation on the function of the cortical layer of the suprarenal glands ^{is} seen from data obtained by M.A. Larina and T.S. Sakhat'skaya (1). However, for the purpose of solving the problem of how irradiation of the animal changes the rate of secretion of the various corticosteroids further investigations are needed.

Resumé

In the irradiation of rabbits with increasing doses of X-rays the rate of secretion of the various corticosteroids is changed differently: the rate of secretion of the corticosterone is essentially unchanged; the rate of secretion of hydrocortisone is increased; the rate of secretion of compound "X" increases with irradiation of the animal with 800-1000 r and decreases with further increase in the irradiation dose.

BIBLIOGRAPHY

1. Larina M.A., Sakhat'skaya T.S. Problems of Endocrinology and Hormone Therapy. 1958, No 4, page 21.
2. Orlova L.V., Rodionov V.M. Med. radiol. [Medical Radiology], 1957, No 2, page 54.
3. Yudayev N.A., Pankov Yu.A., Druzhinina K.V. Problems of Endocrinology and Hormone Therapy. 1956, No 2, page 100.

4. Bowers, J. Z., Melson, D. H., Ray, R., Samuels, L. T. J. Clin. Endocrin, 1952, v. 12, p. 921.
5. Bush, J. E., J. Endocrinol., 1953, No. 9, p. 95.
6. French, A. B., Migeon, C. J., Samuels, L. T. Bowers, J. Z., Radiation Research, 1955, No. 3, p. 226.
7. Rosenfeld, G. Am. J. Physiol., 1958, v. 192, p. 232.
8. Rosenfeld, G., Ungar, F., Doreman, R., Pincus, G. Endocrinology, 1955, v. 56., p. 24.
9. Rosenfeld, G., Ungar, F., Doreman, R., Pincus, G. Endocrinology, 1955, v. 56, p. 30.

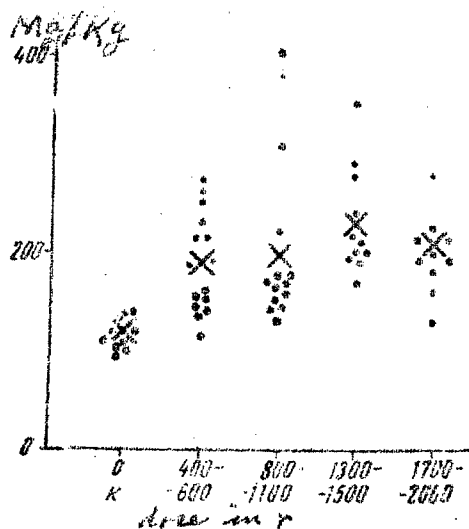


Fig. 1. Ratio of weight of suprarenal glands in milligrams to body weight in KG in non-irradiated (control) and irradiated rabbits. k) control. The dots indicate the individual experiments; the crosses, the average for each group.

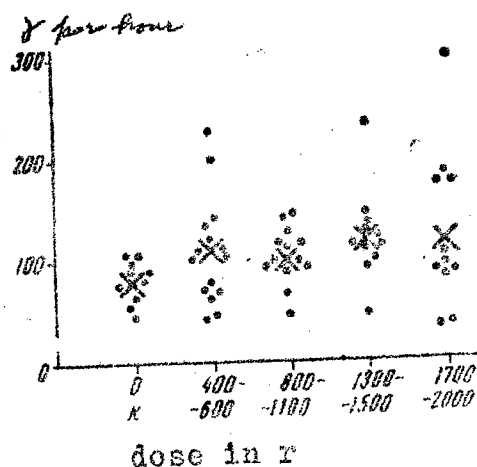


Fig. 2. Rate of secretion of total quantity of corticosteroids (γ per hour) in non-irradiated and irradiated rabbits. The key is the same as for Fig. 1.

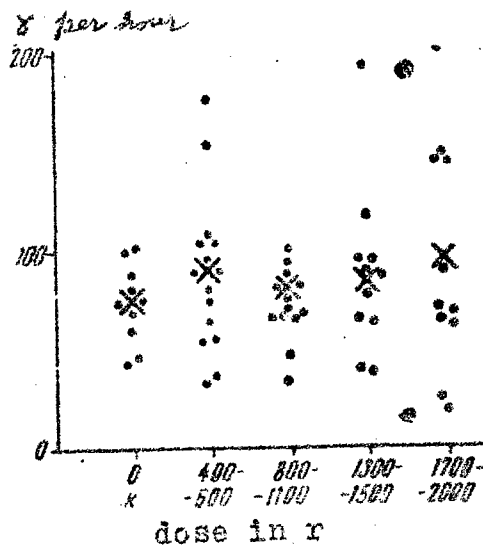


Fig. 3. Rate of secretion of corticosterone (γ per hour) in non-irradiated and irradiated rabbits. The key is the same as for Fig. 1.

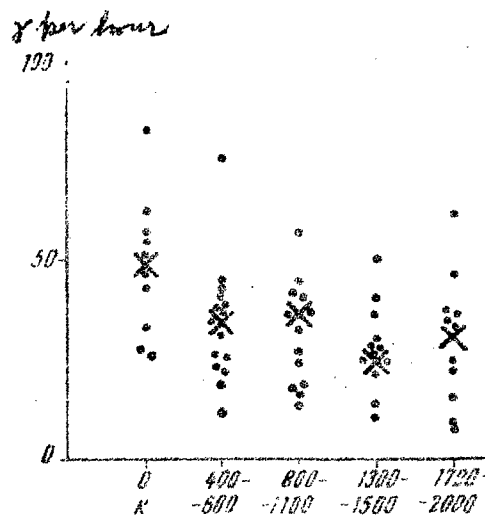


Fig. 4. Rate of secretion of corticosterone (γ per hour per 100 mg of tissue) of suprarenal gland in non-irradiated and irradiated rabbits. The key is the same as for Fig. 1.

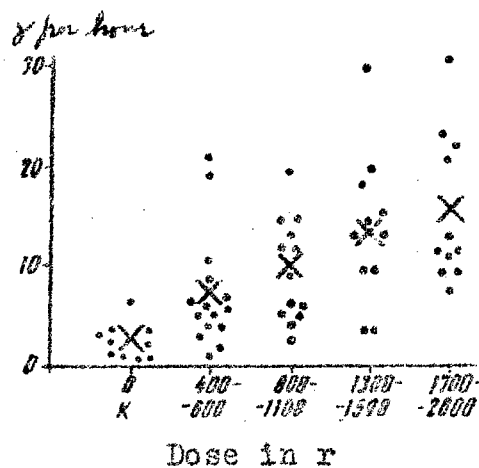


Fig. 5. Rate of secretion of hydrocortisone (γ per hour) in non-irradiated and irradiated rabbits. The key is the same as for Fig. 1.

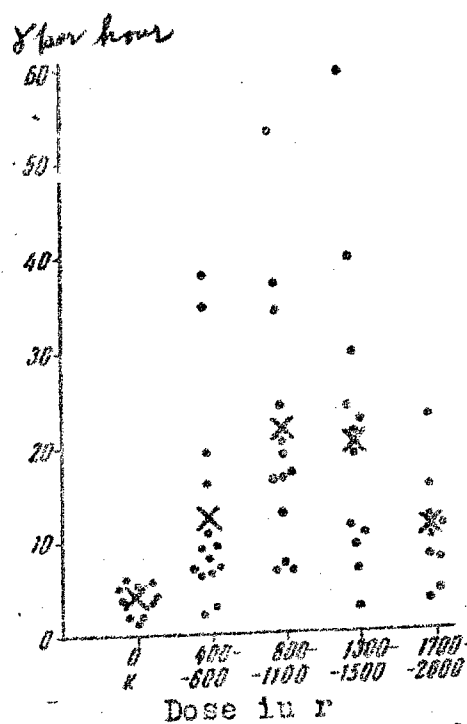


Fig. 6. Rate of secretion of compound "X" (per hour). The key is the same as for Fig. 1.

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